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Wood

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[54] **APPARATUS FOR PROTECTING THE RELIEF VENT ON A DOUBLE-WALLED TANK FOR SURGING LIQUID**

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[21] Appl. No.: **509,879**

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[51] **Int. Cl.**[6] **B65D 51/16**; B65D 90/34

[52] **U.S. Cl.** **220/203.01**; 137/382; 220/89.1; 220/373; 220/724

[58] **Field of Search** 220/89.1, 203, 220/208, 373, 374, 580, 582, 586; 137/377, 382

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Assistant Examiner—Niki M. Kopsidas
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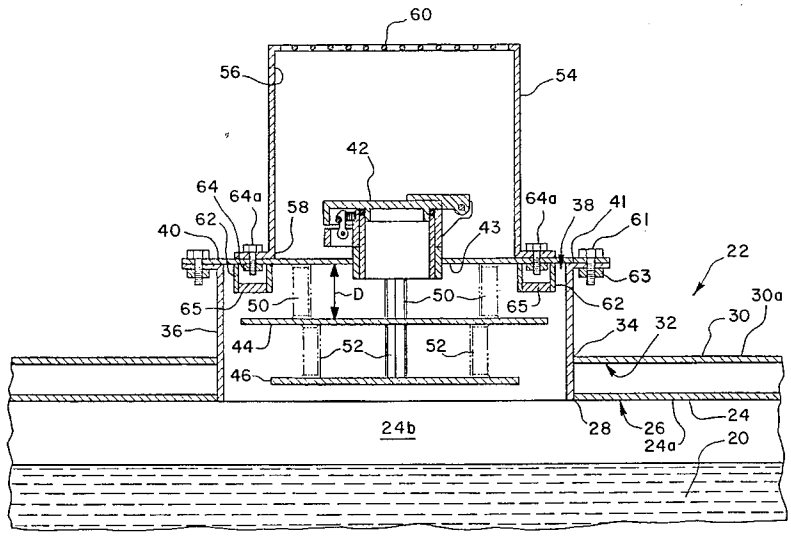
[57] **ABSTRACT**

A double-walled tank assembly having a passageway from an inner tank to an outer tank, the passageway having an outer opening, and a cover removably mounted over the outer opening of the passageway to seal the passageway. The cover has a pressure relief vent and a plate suspended from the cover, within the passageway, below the pressure relief vent, and above the opening in the inner tank. In the event of liquid surging within the tank, the plate prevents the liquid from impinging against the pressure relief vent. In addition, in order to prevent tampering with the pressure relief vent, the cover has an enclosure around the pressure relief vent to prevent tampering.

12 Claims, 6 Drawing Sheets



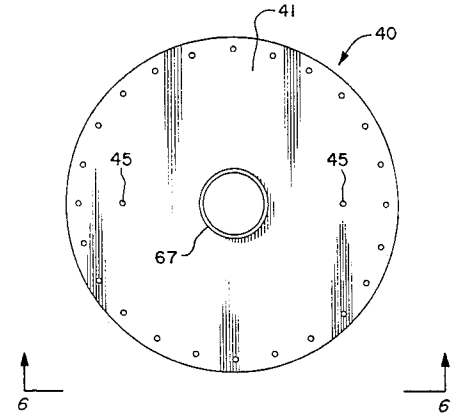


Fig. 1
(Prior Art)

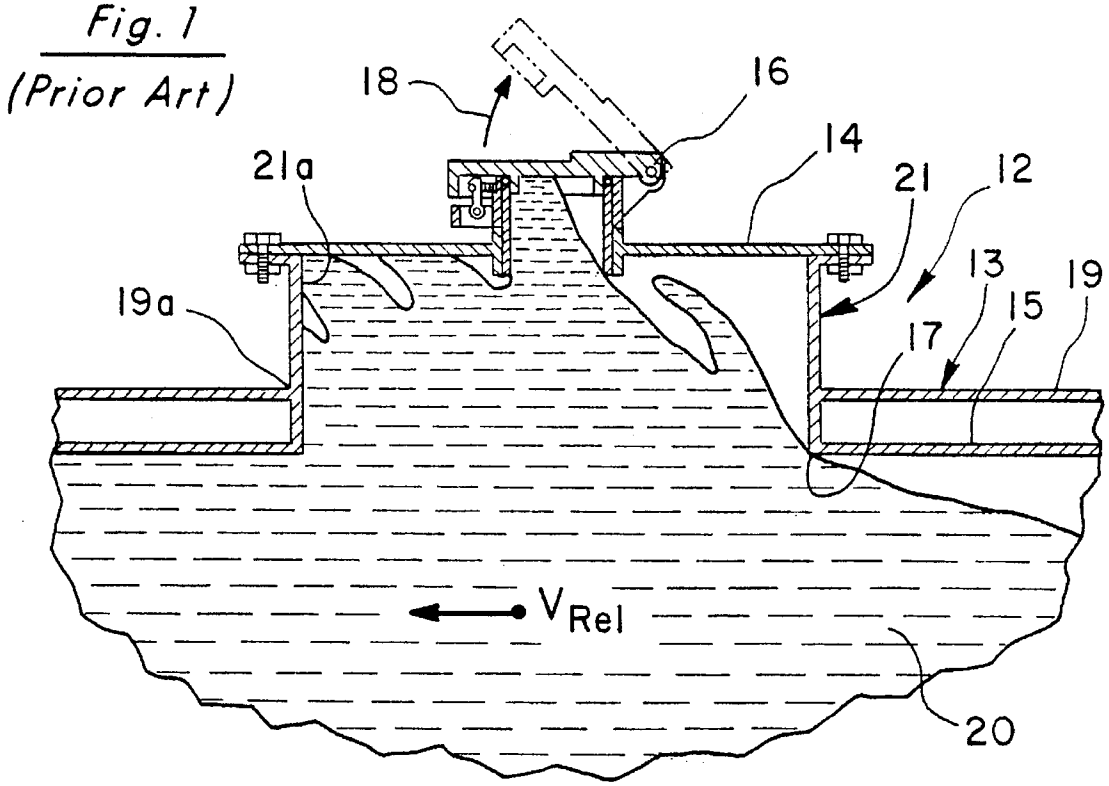


Fig. 9

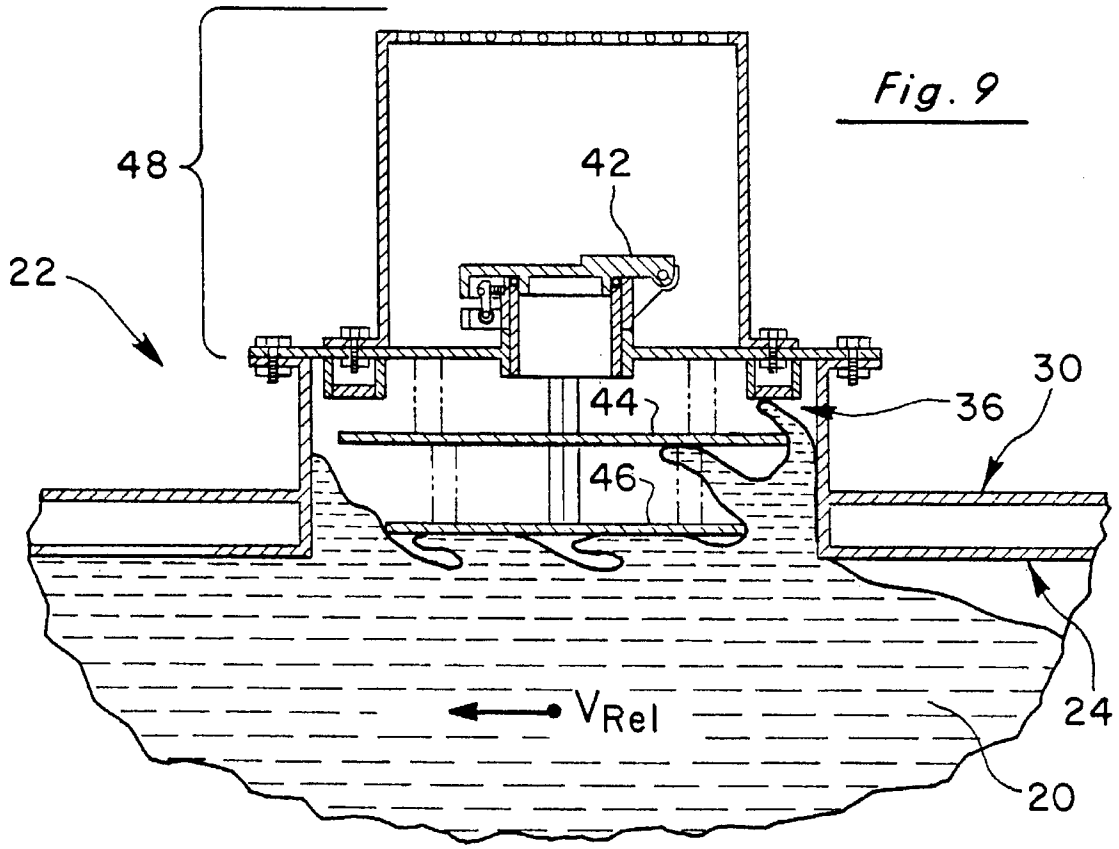
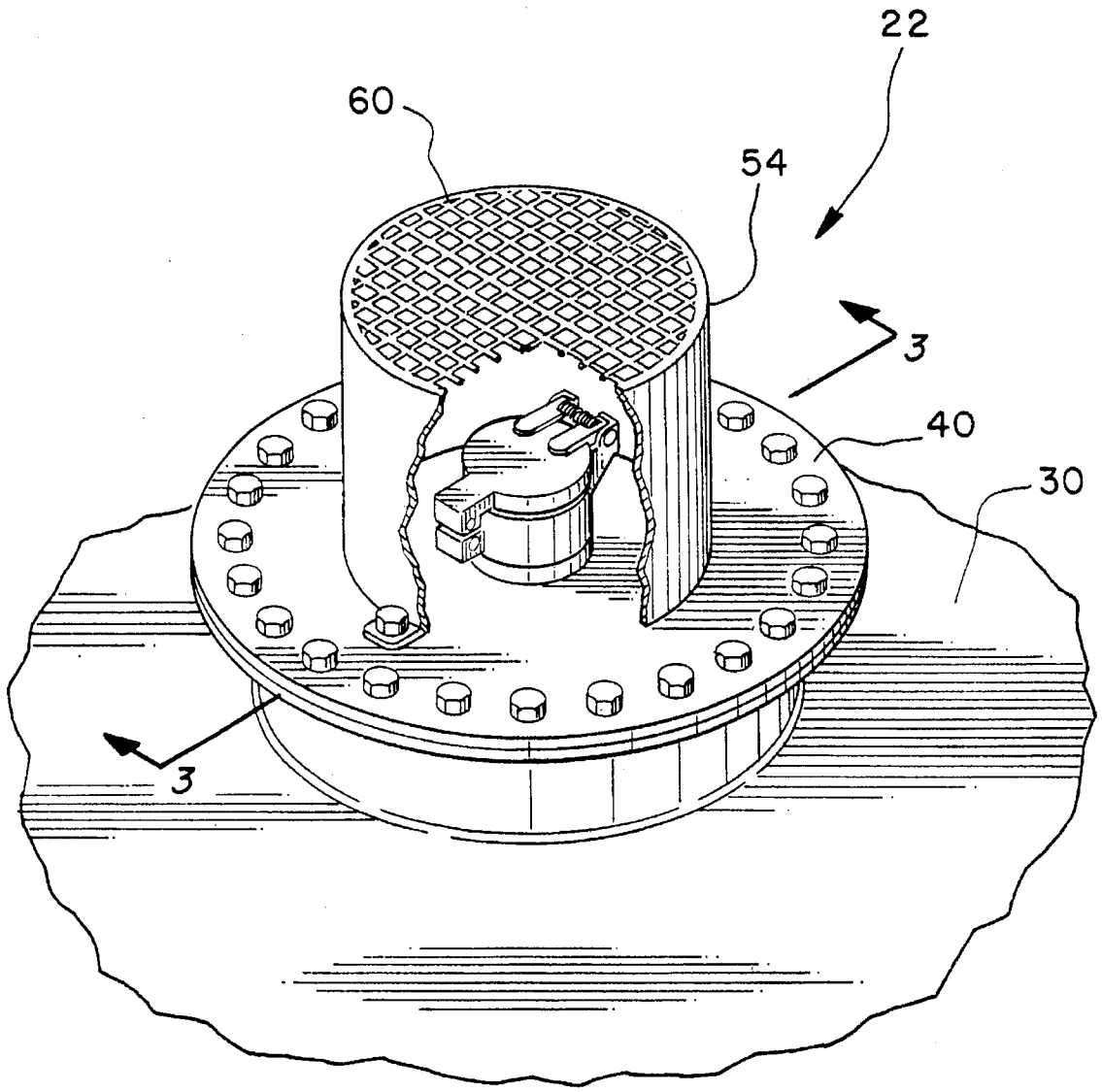


Fig. 2



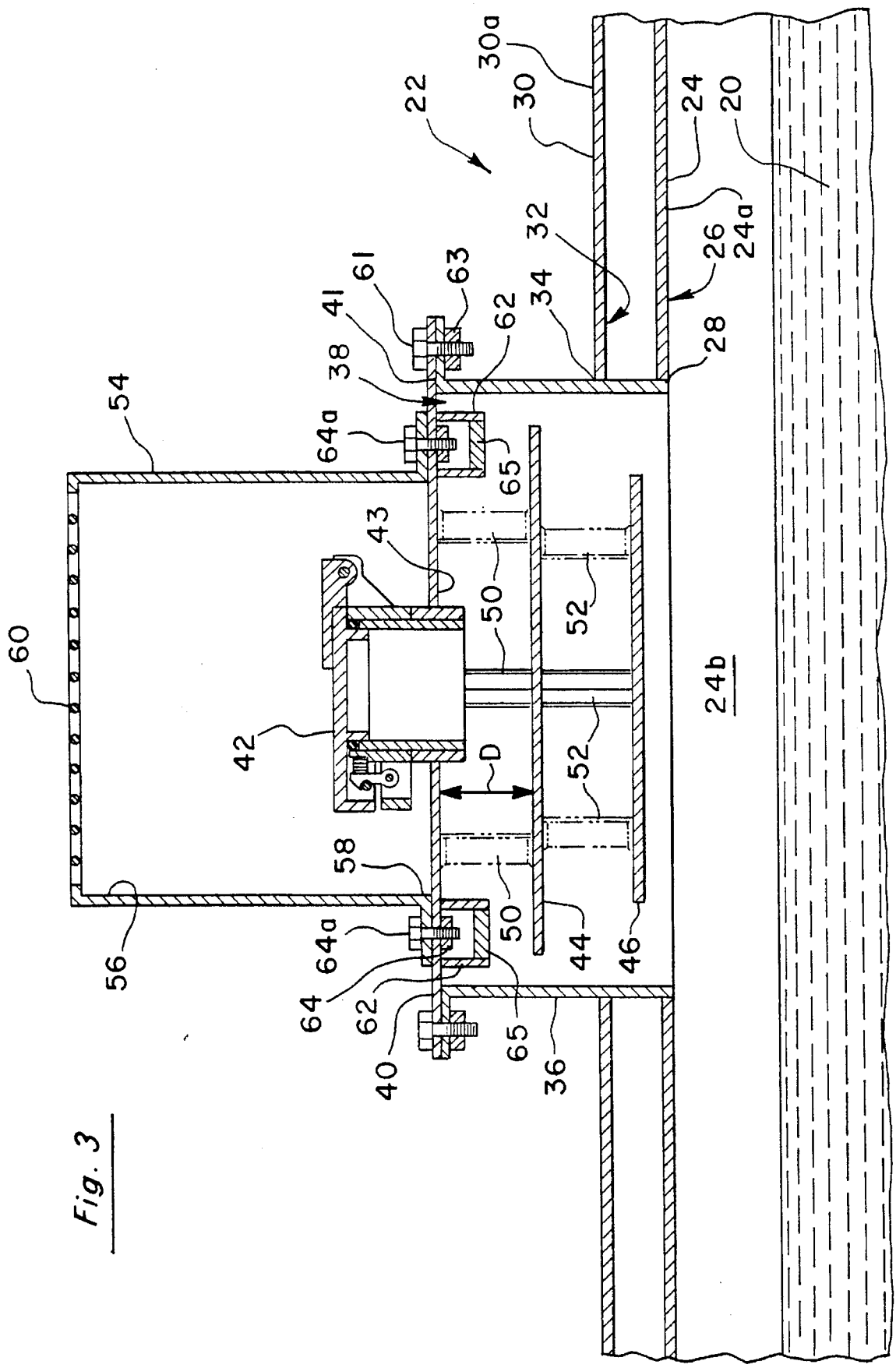

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Fig. 3

Fig. 4

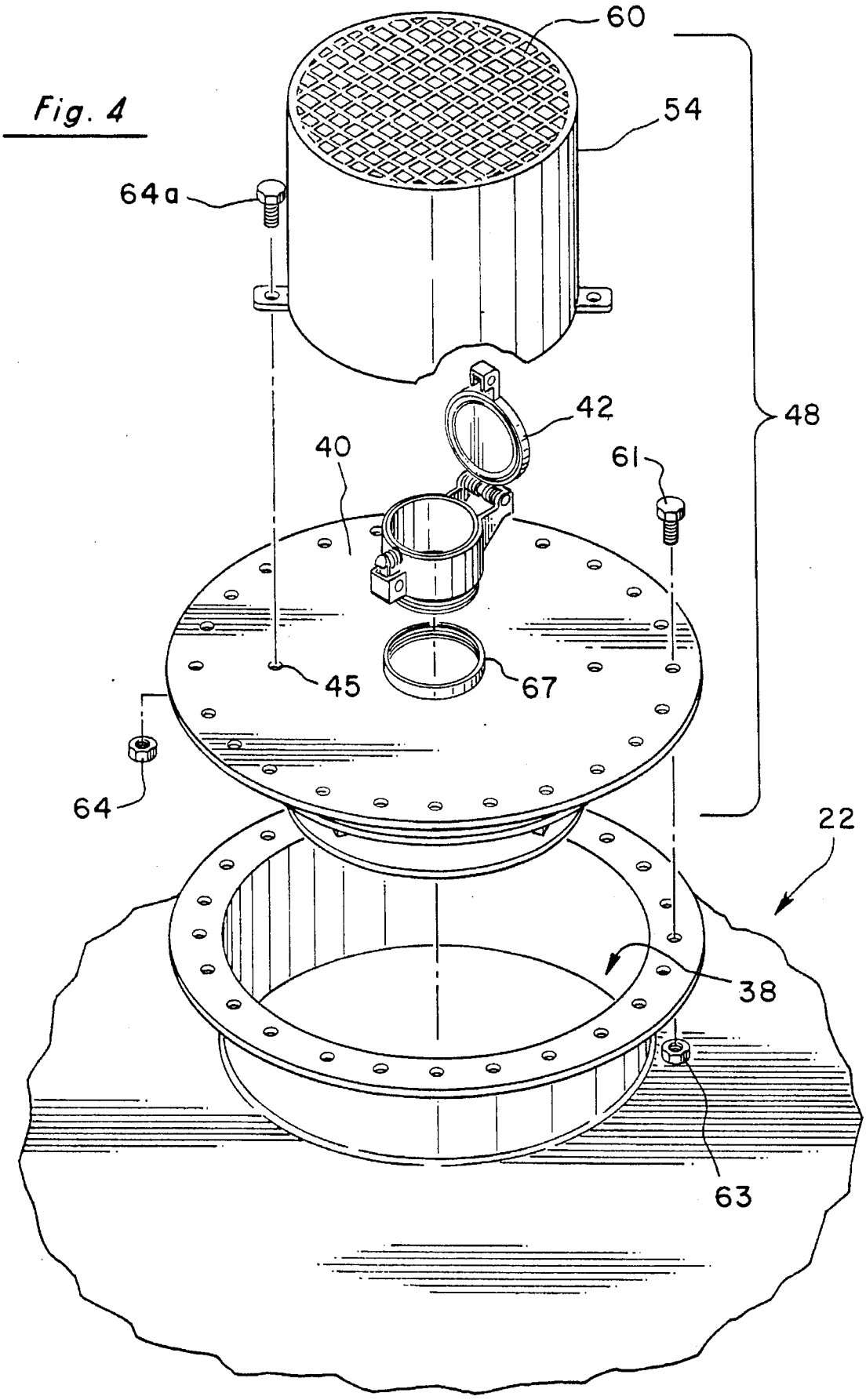
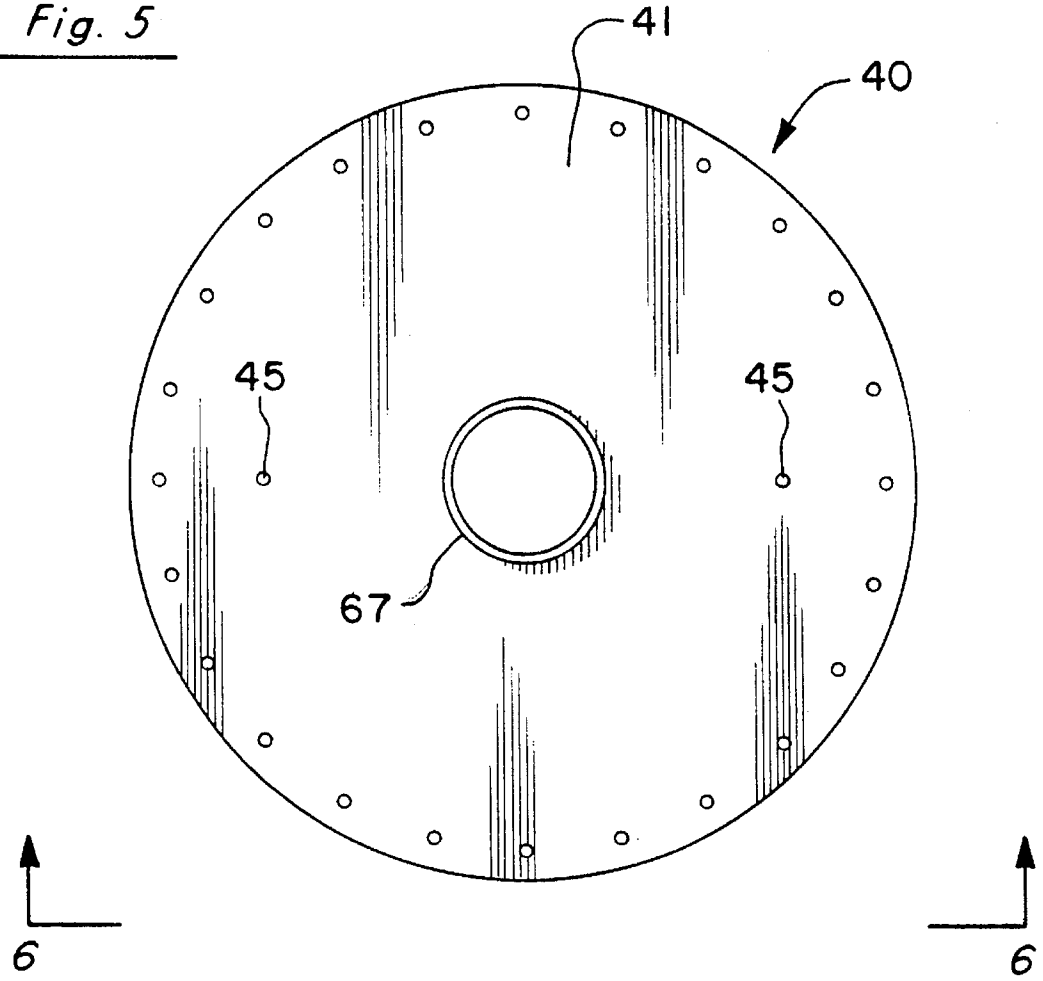


Fig. 5



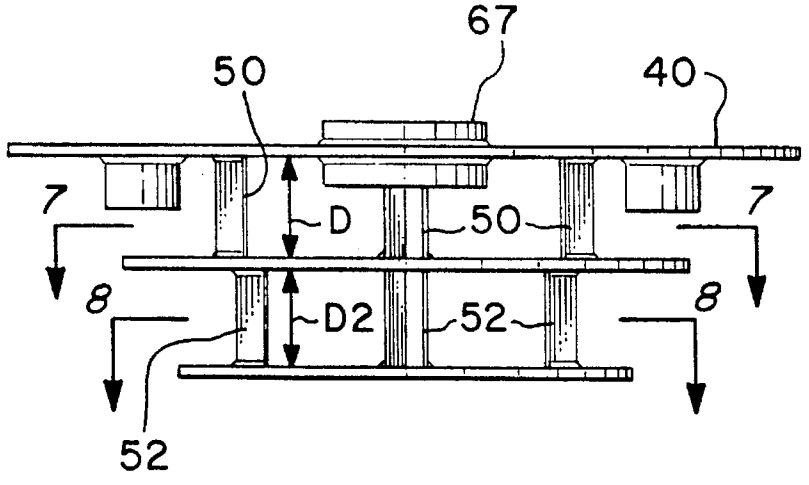


Fig. 6

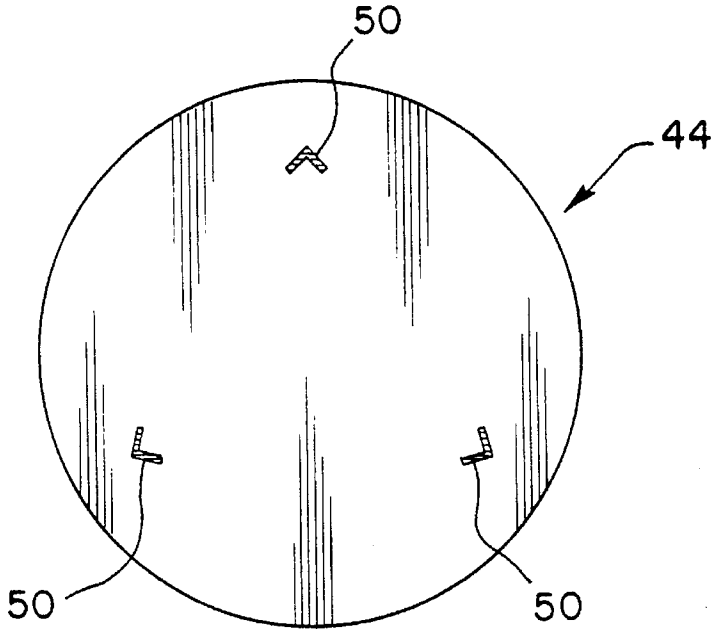


Fig. 7

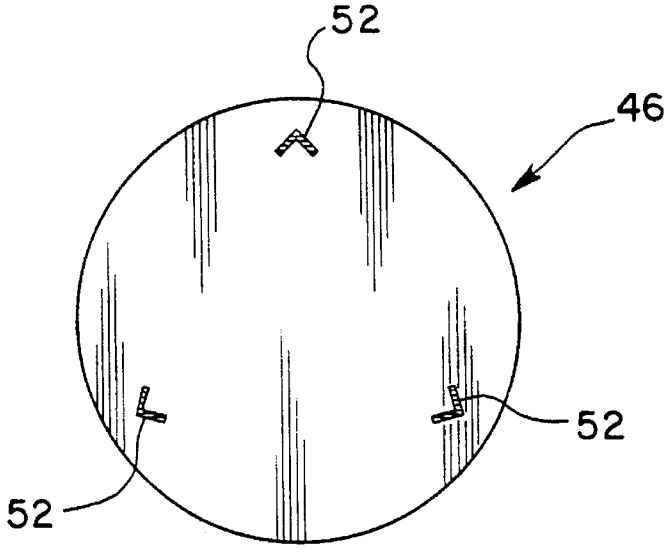


Fig. 8

APPARATUS FOR PROTECTING THE RELIEF VENT ON A DOUBLE-WALLED TANK FOR SURGING LIQUID

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to the field of double-walled storage tanks, and more specifically, to double-walled storage tanks having a pressure relief vent.

2. Statement of the Problem

Double-walled storage tanks are well known in the art for a wide variety of uses. In recent years, double-walled storage tanks have increasingly been used for above-ground storage of gasoline and other flammable liquids. In order to enhance safety, such double-walled tanks typically have a pressure relief vent to prevent the buildup of an excessive pressure within the tank by venting the interior of the tank to the atmosphere when the internal pressure exceeds a predetermined limit. However, when such tanks are transported on the bed of a flat-bed truck or other vehicle, the liquid within the tank surges due to changes in the relative velocities of the truck and tank with respect to the liquid contained within the tank. The surging liquid can impinge on the pressure relief vent, and the dynamic pressure of the surging liquid can cause the vent to open even though the static pressure within the tank has not reached the predetermined limit. The pressure relief vent typically remains open once triggered. The open vent may not be noticed by the driver of the vehicle for quite some time. While the open vent goes unnoticed, the fluid will continue to surge out of the open vent, creating a particularly dangerous problem in the case of flammable liquids. Therefore, a need exists for an apparatus to prevent the surging liquid within a double-walled tank from causing the pressure relief vent of the tank to open.

A number of devices have been invented in the past to prevent liquids from surging out of passageways to tanks. However, none of these devices were for use on a double-walled tank with a pressure relief vent. These prior art devices include the following:

Inventor	Patent No.	Issue Date
Dedman	2,918,192	Dec.22, 1959
Runo	3,128,899	April 14, 1964
Frederick	967,895	April 23, 1910

Dedman discloses an anti-splash venting closure for the circular filler neck of a fuel tank for a gasoline powered mower or the like.

Runo discloses a vent for use with fluid storage tanks in which fluid within the tank is drained by means of a suction force applied to a discharge opening in the tank.

Frederick discloses a breather for a crankcase of an engine to relieve pressure, the breather having baffle plates to allow free passage of air but to prevent oil from being splashed out of the crankcase.

3. Solution to the Problem

None of these prior art references show a double-walled storage tank with a pressure relief vent and means between the pressure relief vent and the liquid in the tank to prevent the liquid from impinging against the pressure relief vent. More specifically, none show a cover with a pressure relief vent and a deflection surface mounted to the cover to prevent the fluid from directly impinging against the vent causing it to open. Instead, all of these prior art references concern devices providing a continuous, constantly open path between the external atmosphere and an interior volume. Hence, these devices would not work in conjunction with a passageway sealed by a cover having a pressure relief vent where the passageway was intended to be sealed except when the internal pressure exceeded a predetermined limit, at which limit the pressure relief vent would open to vent the interior volume to the atmosphere surrounding the tank.

The present invention provides a novel, relatively low cost, and rugged solution to the stated problem by providing a double-walled tank having a passageway from an inner tank to an outer tank, the passageway having an outer opening, and a cover removably mounted over the outer opening of the passageway to seal the passageway. The cover has a pressure relief vent and a plate suspended from the cover, within the passageway, below the pressure relief vent, and above the opening in the inner tank. In the event of liquid surging within the tank, the plate prevents the liquid from impinging against the pressure relief vent. In addition, in order to prevent tampering with the pressure relief vent, the cover has an enclosure around the pressure relief vent to prevent tampering.

SUMMARY OF THE INVENTION

This invention provides a double-walled tank assembly having a plate suspended from a cover to prevent surging liquid from impinging directly against a pressure relief vent mounted to the cover. More specifically, the invention provides a tank assembly having an inner tank for storing a liquid, and an outer tank surrounding the inner tank. A passageway extends upward from the opening in the inner tank through the outer tank. The tank assembly also includes a cover mounted over the outer opening of the passageway. A pressure relief vent is mounted to the cover. The pressure relief vent opens when pressure within the inner tank exceeds a predetermined limit. At least one plate is suspended from the cover at a predetermined distance below the pressure relief vent and above the opening of the inner tank so as not to extend into the inner tank. The plate has dimensions sufficiently large so as to prevent the liquid surging within the inner tank from directly impinging upon the pressure relief vent. However, the plate is not so large as to seal the passageway.

In the preferred embodiment, the clearance between the plate and the interior of the passageway is small compared to the overall diameter of the passageway. Also, in the preferred embodiment, two plates are used, the second having a smaller diameter than the first. The first plate is suspended from the cover, and the second plate is suspended from the first plate but above the opening in the inner tank.

In operation, when the tank assembly is carried on a flat-bed truck, for example, and when the flat-bed truck changes direction or speed, the liquid stored within the tank will surge. The surging liquid will, in some instances, flow up the passageway and impinge against the plates. Without the protection of the plates, the dynamic pressure of the surging liquid could cause the pressure relief vent to open.

One type of pressure relief vent frequently used on double-walled tanks is a simple mechanism consisting of a hinged plate covering a port, the plate being held closed by a spring loaded pin designed to open when the pressure on the inside of the tank exceeds a predetermined limit. However, such vents are easily opened by manually depressing

the pin, thereby subjecting the contents of the tank to the danger of theft. Even with other types of pressure relief vents, it is important to ensure the integrity of the vent by preventing tampering with the vent. Therefore, one embodiment of this invention includes a cover with an enclosure around the vent to prevent tampering while not interfering with the functioning of the pressure relief vent.

These and other advantages, features, and objects of the present invention will be more readily understood in view of the following detailed description and the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention can be more readily understood in conjunction with the accompanying drawings in which:

FIG. **1** is a cross sectional view of a prior art double-walled tank containing a surging liquid that is impinging against a pressure relief vent;

FIG. **2** is a perspective view of a portion of the exterior of the tank assembly of the present invention including the pressure relief vent assembly mounted thereto;

FIG. **3** is a cross-sectional view of the double-walled tank assembly shown in FIG. **2**;

FIG. **4** is an exploded view of the double-walled tank assembly shown in FIG. **2**;

FIG. **5** is a top view of the cover of the pressure relief vent assembly of the tank assembly;

FIG. **6** is a side view of the pressure relief vent assembly;

FIG. **7** is a top view of the first plate of the pressure relief vent assembly;

FIG. **8** is a top view of the second plate of the pressure relief vent assembly;

FIG. **9** is a cross-sectional view of the double-walled tank assembly, including the pressure relief vent assembly mounted thereto, preventing surging liquid from impinging against the pressure relief vent.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to FIG. **1**, a cross sectional view of a double-walled tank **12** of the prior art is shown. The double-walled tank **12** of the prior art has a prior art cover **14** with a pressure relief vent **16** that is designed to move to an open position **18** when the internal pressure of the tank **12** reaches a predetermined limit. The tank **12** contains a liquid **20** that is shown in FIG. **1** surging and impinging against the pressure relief vent **16**. Such surging is typically caused by a difference in the velocities of the liquid **20** and the tank **12** (i.e., the relative velocity of the fluid **20** with respect to the tank **12**, labeled V_{Rel}). The double-walled tank **12** of the prior art has a top portion **13**, an inner tank **15** with an opening **17** near the top portion **13**, an outer tank **19** surrounding the inner tank **15**, the outer tank **19** having an opening **19***a* above the opening **17** of the inner tank **15**, and a passageway **21**. The passageway **21** extends upward from the opening **17** in the inner tank **15** to at least the opening **19***a* in the outer tank **19**. The passageway **21** has an outer opening **21***a*.

When the liquid **20** impinges against the pressure relief vent **16**, as shown in FIG. **1**, the dynamic pressure of the liquid **20** can cause the vent **16** to move to an open position **18** even though the internal static pressure within the tank **12** has not reached the predetermined limit at which the pressure relief vent **16** is designed to open. Double-walled tanks are typically used for gasoline, fuel oil, and other flammable liquids and hazardous materials, and are often transported on flatbed trucks. A pressure relief vent **16** that opens due to liquid **20** impinging on the pressure relief vent **16** may go unnoticed by the driver of the truck for some time. While unnoticed, a significant volume of flammable liquid could surge out of the tank. In this situation and others, the need for the present invention, which prevents surging liquid held in a double-walled tank from causing the pressure relief vent to open, is particularly acute.

The preferred embodiment of the tank assembly **22** of the present invention is shown in FIG. **3**. The tank assembly **22** has an inner tank **24** for storing a liquid **20**. The inner tank **24** is defined by an interior tank wall **24***a* defining an interior volume **24***b* and has a top portion **26** with an opening **28**. An outer tank **30** defined by an exterior wall **30***a* that surrounds the inner tank **24** and is separated by a distance from the interior tank wall **24***a* of the inner tank **24**. The exterior wall **30***a* of the outer tank **30** has a top portion **32** with an opening **34**. A passageway **36** extends upward from the opening **28** in the top portion **26** of the inner tank **24** to at least the opening **34** in the top portion **32** of the outer tank **30**. In this preferred embodiment, the passageway **36** extends above and beyond the opening **34** in the outer tank **30**, The passageway **36** has an outer opening **38**.

As shown in FIG. **4**, a pressure relief vent assembly **48** including a cover **40** is mounted over the outer opening **38** of the tank assembly **22**. The cover **40** is of a predetermined size larger than the outer opening **38** of the passageway **36**. In this preferred embodiment, the cover **40** is removably mounted over the outer opening **38** using stainless steel bolts **61** and nuts **63**, thereby removably sealing the outer opening **38** of the passageway **36**. The cover **40** has an emergency vent passageway **67**. A pressure relief vent **42** is mounted to the cover **40** to block the emergency vent passageway **67** when the pressure relief vent **42** is in a normally closed position (shown in FIG. **3**). The pressure relief vent **42** moves from the closed position to an open position (shown in FIG. **4**) when the pressure within the inner tank **24** exceeds a predetermined limit. FIG. **2** shows a perspective view of the resulting assembly.

Again referring to FIG. **3**, a first plate **44** is suspended from the cover **40** within the passageway **36** at a predetermined distance D below the pressure relief vent **42** and above the top portion **26** of the inner tank **24**. The first plate **44** has dimensions smaller than the passageway **36** but sufficiently large to prevent liquid **20** within the inner tank **24** from impinging upon the pressure relief vent **42** during surging. For example, in a tank assembly **22** where the passageway **36** has an inside diameter of 18 inches, the first plate **44** would preferably be about 15 inches in diameter.

The preferred embodiment of the tank assembly shown in FIG. **3** has a second plate **46** suspended at a predetermined distance D2 below the first plate **44** and above the top portion **26** of the inner tank **24**. Although plates **44** and **46** are shown as circular in shape, it is to be expressly understood that any shape could be used so long as the plates **44** and **46** are of a size sufficiently smaller than the passageway **36** to prevent the liquid **20** from impinging against the pressure relief vent **42**. As shown in the preferred embodiment, the first plate **44** has a substantially planar surface and is mounted to the cover **40** below the emergency vent passageway **67** with the substantially planar surface substantially parallel to the interior surface **43** of the cover **40**.

While the tank assembly **22** described above includes the pressure relief vent assembly **48** (shown in FIG. **4**), the

present invention also includes the pressure relief vent assembly **48** standing alone as a replacement for the prior art cover **14** (shown in FIG. **1**) for mounting to the prior art double-walled tank **12** (shown in FIG. **1**). The pressure relief vent assembly **48** includes the preferred embodiment cover **40**, the pressure relief vent **42**, the first plate **44**, the second plate **46**, and the remaining elements described below.

FIG. **5** shows a top view of the preferred embodiment cover **40** of the pressure relief vent assembly **48** having an exterior surface **41**, two bolt holes **45**, and an interior surface **43** (shown in FIG. **3**). FIG. **6** is a side view of the pressure relief vent assembly **48** shown in FIG. **3** (without the pressure relief vent **42**, and without the hollow tubular member **54** and top planar member **60** described below). As shown in FIGS. **6** and **7**, the first plate **44** is suspended from the cover **40** by three angular members **50** having length D that are attached to the cover **40** and first plate **44** by welding. As shown in FIG. **8**, the second plate **46** is smaller in diameter than the first plate **44**. The second plate **46** is suspended from the first plate **44** by three angular members **52** of length D2 (shown in FIG. **6**).

The pressure relief vent **42** could be subject to tampering. Therefore, to prevent tampering, the pressure relief vent assembly **48** further includes a hollow tubular member **54** (as shown in FIGS. **2**, **3**, and **4**) and a top planar member **60**. The hollow tubular member **54** has a top end **56** and a bottom end **58** (shown in FIG. **3**). As most clearly shown in FIG. **3**, the bottom end **58** is mounted to the exterior surface **41** of the cover **40** over the pressure relief vent **42** to surround the pressure relief vent **42**. The top planar member **60** is mounted to the top end **56** of the hollow tubular member **54** by welding. The top planar member **60** of the preferred embodiment is a steel mesh, but could also be any perforated plate. It is important that the enclosure around the pressure relief vent **42** formed by the hollow tubular member **54**, the top planar member **60**, and the exterior surface **41** of the cover **40** be open to the atmosphere so as to allow venting by the pressure relief vent **42** to the atmosphere.

As shown in FIGS. **3** and **4**, the hollow tubular member **54** is mounted to the cover **40** using two conventional stainless steel bolts **64***a* and nuts **64**. As shown in FIG. **3**, on the interior side **43** of the cover **40** a hollow member **62** is mounted around each bolt hole **45**. In the preferred embodiment, the hollow members **62** are formed from steel tubing and are mounted to the cover **40** by welding so as to form a seal. Each hollow member **62** is threaded to receive a plug **65**. In assembling, the bolts **64***a* are placed through the bolt holes **45**. The nuts **64** are placed on the bolts **64***a* and tightened. Then, the plugs **65** are placed in the hollow members **62** so as to seal the hollow members **62**. Thus, the hollow tubular member **54** and top planar member **60** surround and enclose the pressure relief vent **42** and thereby prevent tampering.

FIG. **9** shows the tank assembly **22**, including the pressure relief vent assembly **48**, in use. As shown, the liquid **20** (with relative velocity with respect to the tank assembly **22** of V_{Rel}) is surging within the inner tank **24**. The surging liquid **20** rises up into the passageway **36**, but is prevented from impinging directly against the pressure relief vent **42** by the second plate **46** and the first plate **44**, thereby preventing the dynamic pressure of the surging liquid **20** from causing the pressure relief vent **42** to open.

Pressure relief vents typically have an opening with an inside diameter of approximately four inches. The opening is sufficiently large to prevent the tank from exploding if excessive pressure builds up within the inner tank due to combustion, thermal expansion of the liquid, etc. The annular areas remaining between the interior of the passageway **36** and the plates **44**, **46** should also be sufficiently large to provide a similar pressure relieving capability. In the preferred embodiment, the annular area around the plates is approximately three or four times larger than the area of the pressure relief vent **42**.

It should be understood that the particular embodiments shown in the drawings and described within this specification are for the purpose of example and should not be construed to limit the invention which will be described in the claims below. Now that a number of examples of the apparatus of the invention have been given, numerous other applications should be evident to one skilled in the art. Further, it is evident that those skilled in the art may now make numerous uses and modifications of the specific embodiments described without departing from the inventive concepts disclosed herein. It should be obvious that the various members described may be made from a variety of materials and using a wide combination of dimensions. Consequently, the invention is to be construed as embracing each and every novel feature and novel combination of the features present in or possessed by the apparatus described herein.

I claim:

1. A tank assembly comprising:

an inner tank for storing a liquid, said inner tank having a top portion with an opening;

an outer tank surrounding said inner tank, said outer tank having a top portion with an opening;

a passageway extending upward from said opening in said top portion of said inner tank to at least said opening in said top portion of said outer tank, said passageway having an outer opening;

a cover mounted over said outer opening of said passageway;

a pressure relief vent mounted to said cover, said pressure relief vent opening when pressure within said inner tank exceeds a predetermined limit;

a plate suspended from said cover within said passageway at a predetermined distance below said pressure relief vent and above said top portion of said inner tank, said plate having dimensions sufficiently large to prevent the liquid surging within said inner tank from directly impinging upon said pressure relief vent; and

at least a second plate suspended from said plate above said top portion of said inner tank.

2. The tank assembly of claim **1** wherein said passageway extends above said opening in said outer tank.

3. The tank assembly of claim **1** wherein said cover is removable from said outer opening of said passageway.

4. The tank assembly of claim **1** wherein said at least a second plate has a smaller surface area than said plate.

5. The tank assembly of claim **1** further comprising a hollow tubular member having a top end and a bottom end, said bottom end of said hollow tubular member mounted to said exterior surface of said cover and mounted over said pressure relief vent thereby surrounding said pressure relief vent, and a top planar member mounted to said top end of said hollow tubular member, wherein said tubular member and said planar member form an enclosure around said pressure relief vent to prevent tampering with said pressure relief vent.

6. A double-walled tank for storing a liquid therein, said double-walled tank comprising:

an interior wall defining an interior volume, said interior wall having a top portion, said interior wall having an opening near said top portion;

an exterior wall surrounding said interior wall and separated a distance from said interior wall, said exterior wall having an opening above the opening of said interior wall;

a first passageway extending between said openings in said interior and exterior walls, said first passageway having an outer opening;

a cover for removably sealing said outer opening of said first passageway, said cover having an exterior surface and an interior surface, said cover further including an emergency vent passageway between said exterior and interior surfaces;

a pressure relief vent having an open position and a closed position, said pressure relief vent moving from said closed position to said open position in response to a predetermined pressure, said pressure relief vent mounted to said cover to block said emergency vent passageway when said pressure relief vent is in said closed position;

a plate having a substantially planer surface of a predetermined size smaller than said outer opening of said first passageway, said plate mounted within said first passageway suspended from said interior surface of said cover below said emergency vent passageway with said planar surface of said plate being substantially parallel to said interior surface of said cover; and

at least a second plate mounted to said plate spaced apart from said plate above said top portion of said inner tank;

wherein when said cover is mounted over said outer opening of said first passageway, the liquid stored in said double-walled tank is prevented from impinging directly against said pressure relief vent by said plate.

7. The double-walled tank of claim **6** wherein said second plate has a smaller surface area than said plate.

8. The double-walled tank of claim **6** further comprising at least one bolt, at least one nut, and a hollow tubular member having a top end and a bottom end, said bottom end having a hole for said bolt, said bottom end of said hollow tubular member mounted by said at least one bolt and said at least one nut to said exterior surface of said cover and mounted over said pressure relief vent, said at least one bolt passing through said at least one hole and through said cover and engaging said at least one nut said hollow tubular member thereby surrounding said pressure relief vent, said tank assembly further comprising a top planar member mounted to said top end of said hollow tubular member, wherein said tubular member and said planar member form an enclosure around said pressure relief vent to prevent tampering with said pressure relief.

9. A pressure relief vent assembly for a double-walled tank with a liquid stored therein, said double-walled tank having a top portion, said double-walled tank having an inner tank, said inner tank having an opening near said top portion, an outer tank surrounding said inner tank, said outer tank having an opening above the opening of said inner tank, a passageway extending upward from the opening in said inner tank to at least the opening in said outer tank, said passageway having an outer opening, said pressure relief vent assembly comprising:

a cover of a predetermined size larger than said outer opening of said first passageway, said cover having an interior surface and an exterior surface;

a pressure relief vent having an open position and a closed position, said pressure relief vent moving from said closed position to said open position in response to a predetermined pressure, said pressure relief vent mounted to said cover;

a first plate of a predetermined size smaller than said passageway, said first plate mounted to said cover spaced apart from said interior surface of said cover and below said pressure relief vent; and

a second plate mounted to said first plate spaced apart from said first plate above said top portion of said inner tank;

wherein when said pressure relief vent assembly is mounted to said double-walled tank with the cover over said outer opening of said passageway, said second plate does not extend into said inner tank and the liquid stored in said double-walled tank is prevented from impinging directly against said pressure relief vent by said first plate and said second plate.

10. The pressure relief vent assembly of claim **9** wherein said at least one plate has a substantially planar surface and is mounted to said cover with said substantially planar surface substantially parallel to said interior surface of said cover.

11. The pressure relief vent assembly of claim **9** wherein said at least a second plate has a smaller surface area than said first plate.

12. The pressure relief vent assembly of claim **9** further comprising:

at least one bolt, at least one nut, and a hollow tubular member having a top end and a bottom end, said bottom end having a hole for said bolt, said bottom end of said hollow tubular member mounted by said at least one bolt and said at least one nut to said exterior surface of said cover and mounted over said pressure relief vent, .said at least one bolt passing through said at least one hole and through said cover and engaging said at least one nut, said hollow tubular member thereby surrounding said pressure relief vent, said tank assembly further comprising a top planar member mounted to said top end of said hollow tubular member, wherein said tubular member and said planar member form an enclosure around said pressure relief vent to prevent tampering with said pressure relief vent.

* * * * *